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AUSTRALIA AND COMET HALLEY, 1985-1986

(This article has been contributed by the Mount Stromlo and Siding Spring Observatories Australian National University)

The return of Comet Halley to the inner solar system during 1985-86 has resulted in the most intensive observational effort ever devoted to a single astronomical object. Australian astronomers, as part of the International Halley Watch network, are playing a major role in this effort.

Comet Halley was named in honour of the noted English astronomer and mathematician, Edmond Halley (1656 - 1742) who in 1705 published calculations showing that comets observed in 1531, 1607 and 1682 were really the one comet. He predicted its return in 1758 and it was sighted late that year, passing perihelion (nearest point of orbit to the sun) in March 1759.

Later calculations identify it with the large bright comet seen during the Norman Conquest of England in 1066 and with other comet sightings at intervals of about 76 years from 240BC.

Bright comets have always been a source of wonder, excitement and (in past times) fear: even today the physical and chemical composition of comets is not fully understood. The present apparition of Comet Halley provides an unprecedented opportunity to vastly increase our knowledge of these visitors from the outer limits of our solar system.

Comets are thought to enter the solar system from a vast swarm of primordial debris known as the Oort cloud. This cloud contains the remnants of material from the time of formation of the solar system and is thought to extend about 2 light years (19,000,000,000,000 km) beyond the known planets. Occasionally, about once every 100,000,000 years, another star passes close to the Oort cloud. The gravitational effects of this passage 'scramble' the orbits of the comets and some begin to fall in towards the sun. The comet thus becomes an infalling sample of the solar system's remote past, and by studying it astronomers can learn something of what the conditions were that led to the evolution of the solar system and, ultimately, to human life.

When they first leave the Oort cloud, comets are small bundles of ices (mainly water with traces of hydrocarbon nitrocarbon compounds) and dust. up to a few tens of kilometers in diameter. As they approach the sun. solar radiation heats the comet and the ice and gasses boil out of it. Interaction with the solar wind (the stream of charged particles that flow out of the sun) blows the gasses back from the head of the comet and causes them to fluoresce forming an ion tail which

always points away from the sun. Dust particles are also lost from the comet and are strewn along the comet's orbit to form a dust tail which may lie in a different direction to the ion tail. When a comet is close to the sun it thus consists of a head (or nucleus), surrounded by a coma (the bright gasses expelled from the nucleus) and having an ion tail of fluorescent gasses and a dust tail. Also surrounding the nucleus is an immense cloud of atomic hydrogen, coming from the breaking up of water molecules in the coma; this hydrogen cloud may grow to the size of the sun.

Most comets fall into elliptical orbits around the sun, with the sun at one focus and a point in the Oort cloud at the other, returning to the inner solar system at long intervals (up to millions of years). Over several passages this orbit may be severely perturbed by the gravitational effects of the planets, particularly Jupiter, and the comet may become 'trapped' inside the solar system, having a shorter orbital period and never returning to the Oort cloud.

The importance of Comet Halley lies in the fact that it is the only fairly young comet for which the period is accurately known, and which has predictable return dates in the near future. It is therefore possible to plan experiments well ahead of the expected return time. During the current passage, Comet Halley will be studied from ground-based observatories, and from a fleet of spacecraft which will rendezvous with the comet in March, 1986. Australian astronomers have a vital role to play in these observations since during the time when the comet is at maximum brightness during March and April, 1986, and at the time of its closest approach to earth on April 11, 1986, Comet Halley will be far south in the sky, inaccessible to the major observatories in the northern hemisphere.

The CSIRO radio telescope at Parkes, N.S.W. is the vital link in communication with the most complex of the spacecraft, the European Space Agency's GIOTTO, due to pass within 500 km of the comet nucleus on March 13, 1986. GIOTTO carries cameras which may provide our first close-ups of a cometary nucleus, as well as experiments designed to sample the chemistry and magnetic fields inside the comet. Since there is a high probability that GIOTTO will be destroyed during its 'close encounter', all data is instantly transmitted to Parkes, thence to Darmstardt, West Germany, for processing. As well as monitoring the GIOTTO encounter, CSIRO scientists will use the Parkes telescope and their smaller millimeter-wave telescope at Epping, N.S.W., to investigate the hydrogen halo and the molecular compounds present in the comet.

From Mount Stromlo, near Canberra, A.C.T., astronomers of the Australian National University's Mount Stromlo and Siding Spring Observatories will be observing Comet Halley at optical wavelengths using the observatory's 1.9 m and 0.8 m telescopes and advanced technology detectors designed and built at the observatories. Experiments planned from Mount Stromlo concentrate on spectroscopic studies, investigating the detailed physical and chemical make-up of the comet, plus infra-red studies, investigating the complex molecules and dusty compounds in the comet.

At the A.N.U.'s Siding Spring Observatory, near Coonabarabran, N.S.W., no less than eight optical telescopes will be involved in the onslaught on Comet Halley. These telescopes include some of the world's most modern telescopes; the brand-new A.N.U. 2.3 m Advanced Technology Telescope (the ATT), the Anglo-Australian Observatory's 3.9 m reflector (the AAT). and the United Kingdom Science and Engineering Research Council's 1.2 m Schmidt camera.

Experiments planned for the AAT, the largest and best-equipped telescope in the southern hemisphere, concentrate on the detailed structure of the comet. The observations include photography of the comet's head. using both conventional cameras and charge-coupled diode arrays (CCDs). and infra-red spectroscopy, which provides information about the molecules and gasses present in the comet.

The most spectacular photographs of Comet Halley are likely to come from the U.K. Schmidt. This telescope is specially designed to have a wide field of view and will be able to photograph

both the head and tail of the comet on the one plate for most of the comet's passage. The Schmidt has been photographically monitoring Comet Halley since August, 1985.

A.N.U. astronomers at Siding Spring will be using six telescopes, ranging in size from the 2.3 m ATT to an ultra-high-speed 20 cm Schmidt camera. A full range of optical investigations is planned; photography, mapping the changing structure of the comet; photometry, monitoring the brightness and colour; polarimetry, investigating the interaction of the comet with the solar magnetic field, and the nature of the dust particles; infra-red observations, studying the molecules and dust; and spectroscopy, the most powerful tool of the astronomer, providing detailed measurements of the physics and chemistry of the comet. Prime telescope will be the 2.3 m. which has the unique facility of being able to change the mode of observation in a matter of seconds, making it possible to run, e.g., spectroscopic and photographic observations practically simultaneously. Coupled with the Mount Stromlo Photon Counting Array, the most advanced light-detecting system in the world, the 2.3 m has a major role to play in the study of Comet Halley.

By the time that Comet Halley leaves the inner solar system toward the end of 1986 the efforts of Australian astronomers will have vastly increased our knowledge of comets, our solar system. and the first steps in the evolution of life.

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